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REGIONAL CONFERENCE
on
EUROPEAN CORN BORER AND CORN EARWORM

Baltimore, Maryland
January 14-15, 1944

M. P. Jones, Chairman
P. L. Rice)
J. O. Pepper) Secretaries
C. M. Packard)
W. G. Bradley)

This regional conference on European corn borer and corn earworm was held in the Lord Baltimore Hotel, and the following persons were present:

Delaware:

Harvey L. Chada, Extension Entomologist, University of Delaware, Newark
Paul L. Rice, Entomologist, University of Delaware, Newark
Ralph L. Walson, County Agent, University of Delaware, Newark
D. O. Wolfenbarger, Entomologist, University of Delaware, Newark

Maryland:

R. Bamford, Department of Botany, University of Maryland, College Park
L. C. Burns, County Agent, Westminster
P. E. Clark, County Agent, Upper Marlboro
George W. Clendaniel, County Agent, Denton
E. N. Cory, Entomologist, University of Maryland, College Park
S. E. Day, County Agent, Annapolis
L. P. Ditman, Entomologist, University of Maryland, College Park
C. Graham, Extension Entomologist, University of Maryland, College Park
D. V. Halter, Assistant County Agent, Hagerstown.
C. Z. Keller, County Agent, Princess Anne
George S. Langford, Entomologist, University of Maryland, College Park
W. Newton Long, Miller Chemical and Fertilizer Corp., Baltimore
C. H. Mahoney, Department of Horticulture, University of Maryland, College Park
J. Smith Michael, Aberdeen
J. Z. Miller, County Agent, Elkton
Parker Mitchell, F. O. Mitchell & Bro., Perryman
Parker Mitchell, Jr., F. O. Mitchell & Bro., Perryman
C. B. Osborn, Jr., C. B. Osborn Sons, Aberdeen
Charles B. Osborn, III, C. B. Osborn Sons, Aberdeen
F. M. Rogers, Assistant County Agent, Frederick
H. R. Shoemaker, County Agent, Frederick
T. B. Symons, Director of Extension Service, College Park
Clay P. Whiteford, Whiteford Packing Company, Whiteford

Pennsylvania:

B. F. Coon, Entomologist, Agricultural Experiment Station, Lancaster
J. O. Pepper, Extension Entomologist, State College
C. A. Thomas, Entomologist, Pennsylvania State College Lab., Kennett Square

U.S.D.A.:

W. A. Baker, Bureau of Entomology and Plant Quarantine, Washington, D. C.
William G. Bradley, Bureau of Entomology and Plant Quarantine, Toledo, Ohio
D. W. Jones, Bureau of Entomology and Plant Quarantine, Moorestown, N. J.
M. P. Jones, Extension Service, Washington, D. C.
C. M. Packard, Bureau of Entomology and Plant Quarantine, Washington, D. C.

Virginia:

Edward K. Vaughan, Extension Plant Pathologist and Entomologist, Blacksburg
Harry G. Walker, Entomologist, Virginia Truck Experiment Station, Norfolk

In the opening remarks the Chairman called attention to how the conference came to be held and stated that as a result of discussions with various groups they felt the need for getting together to discuss recommendations for the Mid-Atlantic States on European corn borer control and that letters were written to the Directors of Extension Service in the five States involved to get their reaction to such a conference. All directors replied favorably and the conference was called. However, New Jersey was unable to send a representative. The Chairman stated that an agenda was arranged as a result of conferences with a number of entomologists, and it was agreed that the topics would logically fall under the following sub-headings: Corn Borer Situation and Problems, 1943; Parasite Colonization Program; Research Activities Under Way; Formulation of Control Recommendations; Scope of Extension Program; and Formulation of Recommendations for Control of Corn Earworm in Sweet Corn and Vegetables. In most cases a representative of the Bureau of Entomology and Plant Quarantine discussed these topics from the Federal viewpoint, and an entomologist from each of the States represented discussed them from the State standpoint.

Corn Borer Situation and Problems, 1943

W. A. Baker. Corn borer infestation now reaches west into Iowa. The population increased in all States except Vermont and New Hampshire. Each succeeding peak of population is greater than previous ones and it is believed that we are not at the top peak yet. On field corn in the Eastern States the average number of borers per plant was as follows in 1943: Pennsylvania, 1 - 3-1/2; New Jersey, 1 - 2; Delaware, 1- 2; Maryland, 1/2 - 2; Virginia, 2 - 4; and North Carolina, 1/2 - 2-1/2. The heaviest population occurred in Bucks and Delaware Counties, Pennsylvania, where there were 13 borers per plant. Early market sweet corn was heavily infested throughout the area from Illinois to the Atlantic coast.

H. L. Chada. Corn borer was first found in Delaware in 1934. Since that time there has been a steady increase in borer population. In 1943 the average number of borers per 100 plants in the State as a whole was 244.7, and it was not until the past year that farmers recognized the borer as a problem and have shown interest in controlling it. The prevailing practice of topping the corn above the ear and leaving the rest of the stalk standing (sometimes for more than a year) has been favorable for the increase of borer population. Preliminary work on the planting dates has indicated that infestations of borers cannot be avoided by late planting. Cage records show that adult moths are present from early in the spring until late in the fall.

E. N. Cory. On the Eastern Shore there were one or two infestations of consequence prior to this year. In 1943 there was an average of 2.1 borers per plant. The infestation was spotty in other parts of the State. Sweet corn in a few canning areas has been rendered practically valueless by the work of the borers. The peak of infestation apparently has not been reached in most counties. A general build-up in population is expected. In 1939 there was extremely severe damage in Somerset County. The corn survey of 1943 was made after harvest and therefore was not fully representative of conditions.

J. O. Pepper. The first borers were found in Erie County in 1919 and there was a compulsory cleanup in 1925-1927 which apparently cut down the infestation considerably. This infestation was entirely of the one generation strain. The next infestation was in Northampton County. This increased much more rapidly. Since 1936 the borer has increased rapidly in 20 southeastern counties. This infestation is of the multiple generation strain and two complete generations and a partial third some years are produced. Infestations and subsequent injury are rapidly increasing each year. Economic crops affected at present are field and sweet corn, early potatoes, and ornamental flowering plants. Clean cultivation is advocated and it is felt that this will aid in control but the practice has not been applied widely enough to affect the general population. About 1,000 acres are devoted to sweet corn production in the Philadelphia area alone. A part of this acreage was plowed under during the past year because of borer infestation. However, much of the crop residue is neglected. Interest in the corn borer has increased materially in the last year and there is much concern about the infestation in potato vines. From observations in potato fields where the borer population was 15 per plant, the yield decreased only from 5 to 10 percent.

H. G. Walker. Virginia has three generations of corn borer. There are violent fluctuations in the populations from year to year, and the populations often vary a great deal in the different counties. The early population is affected by the abundance of early potatoes and observations there were that early potatoes averaging eight borers per hill were not greatly reduced in yield. However, during periods of drouth or other unfavorable growing conditions, the injury might be more severe. As in Delaware, there is an overlapping of generations in some years, while in other years this tendency is not so pronounced.

General Discussion:

Mr. Baker, in answer to a question, stated that there is a single and a multiple generation strain. This multiple generation tendency may even produce a partial fourth generation in parts of Virginia. However, for all practical purposes the multiple generation occurs everywhere. The number of generations depends on the length of the growing season.

Both Dr. Walker and Mr. Baker in answer to a question stated that unless infestations in potatoes occur very early, little harm results. Potatoes seem to be able to recover from rather heavy infestations of borers without much reduction in yield.

Dr. Walker stated there was very little control of borers in potatoes from five applications of bordeaux-calcium arsenate (2-4-6-50 calcium arsenate-bordeaux spray).

Dr. Cory reported an infestation of European corn borer in wheat.

Mr. Chada asked whether we should tell growers of potatoes that they need not be concerned with borers, and the general opinion seemed to be that this should be done.

Mr. Osborn stated that 70 acres of sweet corn planted May 5 had every stalk infested when it was two feet high. This was plowed under and replanted about July 5. From the second planting he harvested about 1 to 1-1/2 tons of corn.

Mr. Thomas called attention to a very heavy infestation in rose plants in southern Chester County. One planting lost 50 percent of the buds.

Parasite Colonization Program

D. W. Jones. Twenty-two species of parasites have been brought in from foreign countries and colonized. Four of these have become established. Liberations have been made in Delaware, Maryland, Pennsylvania, and Virginia. Three species are being reared under laboratory conditions from field collected borers, for field release. A cooperative program on parasite work was initiated this year with the interested States. Funds and personnel were made available by certain of the States for aiding in the parasite release program. Through this aid 175,000 borers have been collected from New Jersey where Lydella grisescens predominates; 175,000 have been obtained from Connecticut where Inareolata punctoria predominates; and 115,000 borers have been obtained in Massachusetts where Macrocentrus gifuensis predominates (the latter is a polyembryonic species). The larvae now are being held in Moorestown, New Jersey, and the parasites will be reared out in the spring. The adult parasites will be shipped in iced containers to the liberation points. Quotas will go to respective States in proportion to State contributions. The Bureau quota will be used in localities previously uncolonized. The three parasites mentioned above are the best of 22 imported species which have been tested in this country on the European corn borer.

P. L. Rice. When opportunity was presented for cooperating with the Bureau in a parasite colonization program, a project for this work was approved. Dr. Wolfenbarger was made available for aiding in the collection work in New Jersey, and additional funds were provided for the collection program. Three colonization areas have already been established in Delaware. Macrocentrus gifuensis has been liberated in all three of these areas, and Lydella grisescens in two. It is hoped that at least two additional colonization points may be established and that all three species of parasites may be liberated at each of these. A check is now being made to determine whether the parasites previously liberated by the Bureau have been established.

E. N. Cory. Five species of parasites have been liberated on the Eastern Shore of Maryland. It is planned that additional liberations will be made during the coming year in the Western Shore counties.

H. G. Walker. Liberations of parasites have been made in the Eastern Shore counties and in Princess Anne County on the mainland. In one locality as many puparia of Lydella as live borers are found. Dissections of third generation borers have shown only a 15 percent parasitism. A total parasitism of as high as 65 percent has been recorded on the earlier generations. Five species of parasites have been liberated, but only Lydella is well established.

General Discussion:

W. A. Baker. There will be no more introductions of parasites from Europe for the duration of the war. Two species of parasites have been liberated in all of the States represented in this conference and a third in all but Delaware and Pennsylvania. A fourth species may be available for colonization work, if desired.

C. M. Packard. Even though considerable work has been done on parasites, there is no indication at present that the combined effect of all of these will reduce the borers to an unimportant status. Consequently, other control methods must be considered in addition to the use of parasites.

E. N. Cory. Does the general clean-up practice interfere with the establishment of parasites?

W. G. Bradley. As the host insect is reduced by a clean-up campaign, parasites are reduced in similar degree. The proportion of borers parasitized is not, however, reduced by clean-up.

P. L. Rice. Since it seems apparent that the corn borer has habits which make it rather susceptible to attack by parasites, why is it that to date little success has been obtained in this field of work?

W. A. Baker. The first difficulty comes in lack of synchronization. Many of the parasites released are not well synchronized with their host. Another point of importance is incompatibility between the parasite and the strain of the corn borer in the colony location.

D. W. Jones. The corn borer has a marked ability to increase rapidly following a drastic reduction in numbers by parasites.

W. G. Bradley. The wrong micro-environment may partially account for the inability of some of the parasites to develop in large numbers. That is why the Bureau is attempting to test them in as many different localities as possible by colonizing the different species in new areas even though they have not proven to be valuable in some of the previous introduction work. It may be that they will do a good job if the proper micro-environment is located. The egg-larval parasite Chelonus annulipes might be suitable for local or State breeding and colonization programs.

In answer to several questions general statements were made that large scale liberations of parasites year after year probably would be of little value in corn borer control; that the Bureau's practice is not to make liberations unless there are five borers or more per 100 plants; and that parasites are only one factor in a complex of several, including clean-up, weather, and crop conditions, affecting borer populations. However, observations at some of the earlier colonization points gave indication that the parasites are an important factor in reducing the number of borers. In New Jersey, for example, an abundance of borers cannot now be found at one of the points where Lydella was liberated.

Research Activities

W. G. Bradley. The Bureau has the following four objectives in mind in its research program.

- (1) Study of resistant varieties in cooperation with Federal and State corn breeders and geneticists.
 - a. Exploratory tests to find resistant germ plasm.
 - b. Development of desirable resistant lines.
 - c. Utilization of resistant lines in commercial hybrids.
- (2) Insecticides.
 - a. Tests of new insecticides in cooperation with chemists.
 - b. Field tests to determine best dosages and application schedules of sprays and dusts.
 - c. Improvement of application equipment in cooperation with Agricultural Engineers, including use of airplanes.

Spraying has been found satisfactory in early market sweet corn, but extension to other types of corn is restricted by cost.
- (3) Biological Control - Colonization of parasites in cooperation with interested State agencies.
- (4) Quantitative appraisal of the value of parasites, clean-up, and other factors in borer control.

Mr. Bradley made an appeal for the various States to contribute to the pool of information on the European corn borer. This pool will be brought up for discussion at the general borer conference to be held at Urbana, Illinois, in March.

H. L. Chada. The resistance of hybrids to borer attacks has been studied during the past three years. As far as the number of borers per plant is concerned, there seems to be little difference between the hybrids and the open pollinated varieties. However, there is a definite indicating of superior yields from the hybrids. In 1941 the hybrids yielded an average of 72.8 bushels per acre, while the corresponding figure for the open pollinated varieties was 69.8. In 1942 the average for the hybrids was 54.9 bushels, while the open pollinated varieties averaged 41.2. Further work on hybrids is contemplated.

G. S. Langford and C. Graham. Hybrids and open pollinated varieties are being compared in Maryland. Hybrids have consistently out-yielded the open pollinated corn, and there is also an indication of a smaller number of borers in the former as compared with the latter. The work on corn borer ties in with that on the Japanese beetle in which an attempt is made to plant corn which will silk after August 10.

C. A. Thomas and J. O. Pepper. Dr. Huber has come to Pennsylvania from the Ohio Station to head up the study of resistant hybrids. So far the results have been similar to those in surrounding States. From 22 to 57 hybrids have been tested per year. The hybrids show more tolerance to the borer than do the open pollinated varieties. The work will be expanded next year.

H. G. Walker. Hybrids have been used a great deal in Virginia and the suitable ones have produced much better yields than the open pollinated varieties. Mr. H. M. Clark, County Agent and Superintendent of our Eastern Shore Sub-station, is continuing the tests with hybrid corn.

General Discussion:

C. B. Osborn. We have applied a method of clean-up as follows: The corn is rolled down after harvest and sowed to a cover crop. This crop is then plowed under the following spring. In the future another plan is contemplated. A cover crop such as soybeans is to be sowed in the corn at the time of the last cultivation. After harvest, the corn and cover crop will be plowed under in the fall and a second cover crop of rye will be sowed. This will then be turned under in the spring.

W. A. Baker. These practices are steps in the right direction. A clean soil surface is fundamental to borer control.

R. L. Walson. Will it pay a person to clean up if his neighbor does not?

W. A. Baker. The borer population will probably not be cut down appreciably, but more corn will probably be raised since the farmer is following a sound cultural practice.

Future Plans for Research

H. G. Walker. Additional parasite work is contemplated.

B. F. Coon. The work will be along two lines, namely:

- (1) A study of hybrids and resistance,
- (2) A study of planting dates.

E. N. Cory. Three lines of work are planned: (1) Insecticide tests, (2) parasite studies, (3) testing planting dates and hybrids.

P. L. Rice. The work will be carried on along the lines of parasite studies and hybrid studies.

W. G. Bradley, C. M. Packard and W. A. Baker. Definite plans are not yet formulated. More work will be done in the Middle West where the borer is advancing in the corn belt. In the East parasite work and survey work will be continued. Hybrids will be tested for performance in the different States. State workers are encouraged to contribute strains for cooperative studies. The work of the Bureau on corn borer resistance ties in with the study of resistance to other insect pests. Lines have now been developed which show resistance to the corn earworm and the southern corn rootworm.

Dr. Chada asked if a late planting of a short-season variety can aid the situation in the East and Mr. Bradley replied that this has possibilities, as is shown by results in the Middle West in 1943.

The question was raised by Dr. Rice as to the effect of various chemical fertilizing elements and compounds upon the resistance of corn to borers and Mr. Bradley stated that some work has been done along this line, but little in the way of conclusions has as yet been reached. Dr. Cory asked about the use of D.D.T. and Mr. Bradley said that this has given promise and may develop after the war.

Mr. Packard stated that D.D.T. has compared very favorably with rotenone.

Formulation of Control Recommendations

In the formulation of control recommendations, copies of "Suggestions for the Control of the European Corn Borer in the Lake States as formulated by a Conference called by Secretary Wickard of Representatives of the Lake States and Federal Department of Agriculture at Chicago, July 28, 1942," were distributed and used as a guide. The various topics were taken up item by item and decisions on the various points were reached. As a result of the discussions, recommendations for the control of European corn borer in the Middle Atlantic States were drafted. A copy of these recommendations is attached to this report.

During the discussions relative to insecticidal control, comments were made by Mr. Bradley, Mr. Baker and Mr. Packard on the current results from use of insecticides in corn borer control. Rotenone used as a spray at the rate of 4 pounds of ground root (containing 5% rotenone) per 100 gallons, gave results which were far superior to those obtained from any of the dusts. About 150 gallons of spray were used per acre per application, and four applications were made at five-day intervals. In spite of a very high borer population (3,000 per 100 stalks on checks) there was an average of only 1/2 borer per ear on the plots sprayed as above. Applications of 3/4 to 1 percent rotenone dust or black leaf 155 did not give borer-free corn, although much of the corn could be sold on the market. A high-clearance spray machine with three nozzles directed at each of two rows was used as the spraying equipment. A coarse spray was found to give the best results. The cost of the spray application was about \$25.00 per acre, while the cost of dusting was from \$35.00 to \$40.00 per acre. A reduction in numbers of borers of 70 percent was the best result obtained from dusts, while reductions of from 90 to 95 percent were obtained from sprays. Cryolite is an outstanding insecticide for use against the European corn borer, but it cannot be used because of severe burning it produces on the corn plant. Dust will probably still be the most practical material for use in corn borer control in Victory gardens.

Scope of Extension Activities

J. O. Pepper. A clean-up on a county wide basis or for groups of counties will be emphasized. This work will be carried out through the community leaders. A set of 20 color slides is being purchased by many county agents for educational work in their respective counties. Hybrid field corn is being recommended. Destruction of early sweet corn stalks will be urged. In order to provide spraying equipment, the possibility of conversion of potato sprayers to a form which can be used on corn is being suggested. Plowing demonstrations will be carried out. The keen interest in corn borer control has been shown through the ordering of 50,000 copies of a new corn borer circular. Large numbers of educational meetings are being held over the State. Four letters sent to growers in heavily infested counties have proven to be useful. These four letters take up the following topics:

- (1) Work for fall and winter.
- (2) Work for late winter and spring.
- (3) Final warning on clean-up.
- (4) Summer letter on control.

Radio programs on the subject of corn borer will be broadcast. In addition to this "plugs" will be prepared for the use of station announcers.

H. L. Chada. Educational meetings on borer control will be held. If possible, plowing demonstrations will be put on. Hybrids will be stressed, since they have been shown to be definitely more tolerant to the borer. Mimeographed circulars will be published giving the results of hybrid tests and biology and control of borers. One circular will include oil treatment for corn earworm.

H. G. Walker. Farmers are not yet greatly interested in control, so little extension work is planned.

C. Graham and E. N. Cory. No definite program has as yet been outlined. Some educational meetings are planned for heavily infested counties. No general program has been put into effect because of lack of serious damage except in limited areas. Timely newspaper articles will be put out.

General Discussions:

H. G. Walker. The Virginia Truck Experiment Station has had poor results from the use of the radio in extension work, especially with farmers.

H. L. Chada. Extension radio programs broadcast through Station WDEI, Wilmington, have been very well received in Delaware.

W. G. Bradley. It would be desirable to provide a system by which growers can be informed just when to apply corn borer insecticides rather than depending upon them to look for the eggs themselves.

G. S. Langford and E. N. Cory. Much aid in this line could be supplied from observers posted in each community. Some of this work has been done in connection with other insect pests in Maryland.

J. O. Pepper. In an attempt to make a general statement regarding the application of insecticides, Pennsylvania from field observations has information that first generation eggs generally start to hatch when the early sweet corn is 12 to 15 inches high. In some States, 4-H Club boys have been used in making observations on insect infestations. Their reports have proven to be quite reliable.

G. S. Langford. Community leaders are the ones through whom to introduce control practices.

Formulation of Recommendations for Control of Corn Earworm in Sweet Corn and Vegetables

L. P. Ditman. Earworm control is under three heads: lima and string beans; tomatoes; and corn.

Beans: Cryolite was used but does not give 100 percent control. However, it is profitable and practical. It gives 70-90 percent reduction on lima and snap beans. One grower was well pleased and felt his problems were solved. String beans are treated when the first blossoms begin to drop with one application of cryolite. While rather good control is obtained with cryolite, no control is obtained with pyrethrum or rotenone mixture. Cryolite gave very poor control for bean beetle.

Tomatoes: About the same control is obtained as on beans if cryolite is applied at the right time. It must be applied before fruit injury is apparent. In general Maryland losses seldom exceed 5 percent and control is not warranted. The loss is occasionally heavy in the green wrapped crop but control is impracticable unless application can be properly timed.

Corn: The use of arsenical dusts is not favored because of residue. About 65 percent control was obtained. Several years of intensive work has been done on the use of oil with pyrethrum, rotenone, nicotine, and dichloroethyl ether. Mineral oil with 0.1 percent pyrethrum is not effective, nor with rotenone or nicotine. We have never used pyrethrum at 0.2 percent because of the expense. Dichloroethyl ether is as effective as any of the materials used and gave up to 90 percent control; 75-80 percent control was obtained by desilking. As the season advances, the efficiency drops. Treatment is expensive because much labor is required. Commercial men and canners do not use control as far as is known. The market is accustomed to wormy corn and will take it. Therefore treatment is unprofitable.

H. L. Chada. I have wondered why more sweet corn has not been raised and earworm is the limiting factor. We have recommended mineral oil treatment for home garden use and a few who have tried it obtained good results. On lima beans people are afraid to use cryolite because of the residue as the vines are used for feed. We experimented with 3, 2 and 1 applications and analyzed the samples for residue. There were no significant differences among the treatments in the amount of residue. We were surprised at the amount of fluorine in untreated check, 15 parts per million in untreated, and about 80 parts per million on treated samples. The residues are thought to be harmless to animals. There was not enough earworm in 1943 to determine the degree of control.

General Discussion:

L. P. Ditman. Experiments in 1942 with cryolite-calcium arsenate dust mixtures on lima beans at different rates gave no significant differences in yields. Earworm infestations in beans was very light. Over 80 percent control of earworm was obtained in best treatments (cryolite dusts). With calcium arsenate dusts severe injury occurred one year and one year we got injury to snap bean pods rather than to the foliage.

E. N. Cory. Earworm injury to beans has been sporadic. Hundreds of untreated acres were plowed down in Maryland in 1942. Timing of application must be made for individual fields.

H. L. Chada. By training cannery field men where and what to look for, the effectiveness of extension entomology can be greatly increased. As an example, the field men for one company were shown corn earworm eggs on lima beans and where to look for them. The company furnished them with hand lenses and they made regular examinations for corn earworm eggs themselves, thereby keeping a close check on the situation.

L. P. Ditman. Mr. Dicke and I think outbreaks of earworm can be predicted. They depend on winter conditions. The chances are that 1944 will be a mild year for earworm. However, if earworm is severe in early sweet corn, it will probably be serious on beans.

H. G. Walker. Many growers are treating beans in the fall with cryolite-sulfur dust for bean beetle and earworm. Bean beetle is easier to control when the larvae are small. Earworms cut off pods and eat blossoms. There are more pods and fewer worms when the beans are treated. Several tests have been made on tomatoes but the infestation was too small for significant results. One grower tried cornmeal bait with apparent success, broadcasted by hand. On sweet corn promising results have been obtained with mineral oil containing either pyrethrum or dichloroethyl ether. However, growers are not interested because of the trouble and expense. Desilking is not always effective because of the large number of eggs often laid on other parts of plants than the ears.

L. P. Ditman and E. N. Cory. Poor results have been obtained with oil-pyrethrum in seed field corn.

C. M. Packard. Barber got excellent results on seed sweet corn in Idaho. The results were given in Idaho War Circular No. 20, Control of the Corn Earworm in Seed Sweet Corn.

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